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Health Promotion and Chronic Disease Prevention in Canada: Research, Policy and Practice is the monthly, online scientific journal of the Health Promotion and Chronic Disease Prevention Branch of the Public Health Agency of Canada. The journal publishes articles on disease prevention, health promotion and health equity in the areas of chronic diseases, injuries and life course health. Content includes research from fields such as public/community health, epidemiology, biostatistics, the behavioural and social sciences, and health services or economics.

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Knowledge to action for solving complex problems: insights from a review of nine international cases

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Abstract

Introduction: Solving complex problems such as preventing chronic diseases introduces unique challenges for the creation and application of knowledge, or knowledge to action (KTA). KTA approaches that apply principles of systems thinking are thought to hold promise, but practical strategies for their application are not well understood. In this paper we report the results of a scan of systems approaches to KTA with a goal to identify how to optimize their implementation and impact.

Methods: A 5-person advisory group purposefully selected 9 initiatives to achieve diversity on issues addressed and organizational forms. Information on each case was gathered from documents and through telephone interviews with primary contacts within each organization. Following verification of case descriptions, an inductive analysis was conducted within and across cases.

Results: The cases revealed 5 guidelines for moving from conceiving KTA systems to implementing them: 1) establish and nurture relationships, 2) co-produce and curate knowledge, 3) create feedback loops, 4) frame as systems interventions rather than projects, and 5) consider variations across time and place.

Conclusion: Results from the environmental scan are a modest start to translating systems concepts for KTA into practice. Use of the strategies revealed in the scan may improve KTA for solving complex public health problems. The strategies themselves will benefit from the development of a science that aims to understand adaptation and ongoing learning from policy and practice interventions, strengthens enduring relationships, and fills *system* gaps in addition to *evidence* gaps. Systems approaches to KTA will also benefit from robust evaluations.

Keywords: intervention studies, public health, knowledge transfer, systems approach

Key findings

- Solving complex problems like preventing chronic diseases requires sharing and using knowledge of what works and how to support positive changes in communities.
- Our scan of 9 diverse examples of using knowledge for action found that there is no single formula or recipe for applying knowledge to specific problems; that solutions need to emerge and adapt over time based on feedback and evaluation; lasting, diverse relationships should be nimble and focus on sharing resources to inspire innovative thinking and solutions; and we need to build and use many types of knowledge together across sectors.

Introduction

Public health problems such as preventing chronic diseases arise and persist as a result of multiple physiological, behavioural and environmental factors and their interactions.[1,2] Solutions to these complex problems require new approaches to how knowledge is created and applied.[3-5] In this paper we refer to these as "systems approaches for knowledge to action (KTA)."

Systems approaches to KTA build on linear approaches that emphasize effective packaging and dissemination of knowledge products and on relationship approaches that emphasize effective partnerships for developing and sharing knowledge. Systems approaches recognize that dissemination processes and relationships themselves are shaped, embedded and organized through structures that influence the types of interactions that occur among multiple stakeholders with unique worldviews, priorities, languages, means of communication and expectations.[6] These stakeholders are tied together by a system (which in turn is shaped by culture, structures, priorities and capacities[7]) that requires activation if its various parts are to be linked together. Consequently, a systems way of thinking is

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needed to bring about that activation for the purposes of KTA.[8,9]

While the need for systems approaches to KTA is acknowledged, and concepts are gaining clarity, practical strategies to design and implement systems approaches to KTA are very limited.[8,10,11] The purpose of the environmental scan reported in this paper was to begin to show some practical strategies that may usefully guide the design, implementation and impact of KTA initiatives to solve complex problems.

Chronic diseases are a serious and urgent problem worldwide. In 2005, 60% of total deaths worldwide were attributed to chronic diseases, and a 17% increase is projected from 2005 to 2015.[12] Although it has been estimated that up to 50% of cancer,[13] 90% of cardiovascular disease,[14] and 91% of diabetes[15] are preventable, significant and scaled-up investments in population-level prevention interventions continue to be insufficient. Even modest reductions in chronic disease risk factors would save tens of thousands of person-years of life and hundreds of millions in direct health care costs worldwide each year.[16,17]

Chronic diseases are also complex problems. Their complexity arises from a dynamic interplay of factors that contribute to the development and persistence of chronic conditions. Factors span a wide range, including individual physiology and behaviour, institutional arrangements (e.g. health and social service organization interactions), and physical and social environments at local through societal levels (e.g. neighbourhood design, social cohesion, food supply and distribution).[18]

Complex problems such as chronic diseases do not respond to simple, independent, one-off solutions; they require deliberately coordinated sets of interventions and creative efforts at many jurisdictional levels (e.g. regional, provincial, national, international)[4] and system levels (e.g. paradigm, goals, organizational structures).[5,19] They require the engagement of actors and organizations involved with research, policy and practice and from health and non-health sectors. They also require tailoring policy and program interventions to diverse contexts and ongoing adaptation of interventions in dynamic environments,[4] all with a goal to change health behaviours and the underlying conditions of risk in the case of chronic diseases.

Multi-faceted and dynamic solutions to complex problems introduce unique challenges for the creation and use of knowledge.[20-23] For example, it is now widely acknowledged that application of the concept of evidence-based medicine as originally conceived is not well-suited to public health interventions,[24] making the direct application of research findings to various settings, time periods and populations problematic. In contrast, effective KTA approaches will be dynamic, multi-directional processes of engaging (often diverse) stakeholders to co-create, synthesize, share and use knowledge in order to inform decision-making and foster change in the contexts and based on needs of policy and program settings.[25]

Consequently, new approaches to evidence-informed public health are being explored and have led to many calls for the application of concepts and methods of systems science.[8,23,26-30] Responses to these calls have resulted in a growing number of empirical studies that use systems modelling and network analysis techniques. These empirical studies have also contributed to the body of literature on the promise of applying systems thinking, variably defined, to knowledge development and use in population and public health.[10,26-28,31,32] This emerging literature is relatively silent on the translation of concepts and principles of systems thinking into practical strategies for creating and using knowledge to solve complex problems.

Organizations such as the Public Health Agency of Canada and Propel Centre for Population Health Impact with pan-Canadian mandates to accelerate KTA for chronic disease prevention are attempting to fill this gap. The analysis and synthesis we describe in this paper are based on a scan of initiatives, all of which were addressing complex problems, included a focus on both creating and using knowledge, and applied principles of systems thinking in their KTA efforts.

Methods

A small advisory group (authors BR, KR, DF, DS, AB), representing public health research, policy and KTA organizations with a history of collaboration on projects related to KTA for chronic disease prevention, chose 3 main criteria to use in the search for organizations and their KTA initiatives: (1) intermediaries (as opposed to direct service delivery organizations) addressing a complex issue; (2) groups that are seeking to intervene at multiple levels in a system; and (3) groups that have used specific strategies for KTA informed by systems thinking.

Principles of systems thinking cover a wide range from many disciplines and schools of thought. For the scan, we integrated ideas from several systems thinkers[3,34-36] and adapted them to a public health context. Through discussion and consensus among advisory group members, we developed 12 systems principles for solving complex public health problems and organized these principles into 3 overarching concepts: coherence, connectivity and continuous learning (see Table 1).

Using the 3 criteria for case selection, we identified an initial list of 30 KTA cases through a web-based search, a search of grey and published papers that explore complex or systems approaches to KTA, and by requesting nominations from people known to the advisory group. The initial set of cases were from Canada and other developed countries.

By reviewing publicly available documentation on the initial set of 30 potential cases, we chose 9 cases that best fitted the criteria and scope of the scan (see Table 2). We excluded cases from the analysis if they were direct service delivery organizations; intervened only at one level of a system (e.g. focussed only on individual behaviour change); or did not undertake KTA approaches (e.g. some organizations produced discussion papers on the concepts or theories of system approaches but did not undertake specific initiatives).

The 9 cases included in the scan were diverse, addressing a variety of areas and using different organizational forms. In

TABLE 1
Principles of systems thinking for solving complex public health problems

Coherence	Connectivity	Continuous learning
Match capacity with complexity	Establish networks and teams	A reductionist paradigm is not that helpful
Act locally, connect regionally, learn globally	Support individuals	Set functional goals
Transformative leadership	Build authentic trust	Assess effectiveness
Disruptive innovation	Distribute decision, action and authority	Linkage and exchange processes

some cases KTA was a core purpose (for example, ResearchImpact and Plexus) and in others it was an ancillary activity in support of other objectives (e.g. the National Treatment Strategy and Causeway). Some examples explicitly used a systems / complexity framing (e.g. Tamarack, Plexus and CEIPS), whereas others had features and characteristics consistent with a systems approach but did not use that language or framing directly (e.g. INSPIRE, ResearchImpact). Explicitly or implicitly, all of the organizations' KTA activities drew on principles of systems thinking.

A set of questions to guide documentation and analysis covered organizational vision, objectives, guiding principles, collaborators, activities, operational definitions, results and lessons learned. Initial data collection included analysis of publicly available documentation (reports/publications, website information) and a telephone interview with a primary contact within each organization who knew most about each case (e.g. the executive director or the project lead/coordinator). The primary contacts verified case descriptions and provided additional information, both directly and by recommending other reports that the advisory group had not previously reviewed.

We conducted an inductive review of the case documentation, informed by the system principles in Table 1, without being constrained by them. The principles were used as a preliminary analytic framework to examine how they were implemented in one or more cases. Themes related to practical strategies (e.g. people, processes, structures) were generated and coded in the case documentation. The analysis was completed by 2 researchers (authors JG, TP) and supplemented with reflections and analysis from the advisory group based on a review of documented examples of each theme. We then compared themes for similarities and differences, and identification of specific examples of themes were then completed across cases.

Results

Based on the scan analysis, we identified 5 guidelines on implementing systems approaches to KTA:

TABLE 2
Case organizations in the scan

Organization	Type of knowledge-to-action initiative
Tamarack Institute – Vibrant Communities Canada (Toronto, Ontario, Canada) http://tamarackcommunity.ca	Example of an intermediary that puts learning, knowledge production and dissemination at the centre of a significant national poverty reduction initiative
Framework (Toronto, Ontario, Canada) http://www.frameworkorg.org	Example of a small, creative organization that conducted a pilot with several organizations to explore how readily available technological tools could help the organizations gather and share evidence, practice and knowledge
Plexus Institute (Washington, DC, USA) http://www.plexusinstitute.org	Example of a capacity-building, action-research organization that was built explicitly around complexity and systems thinking
Centre of Excellence in Intervention and Prevention Science (CEIPS) (Victoria, Australia) http://ceips.org.au/	Example of a public health research centre
INSPIRE's EPISCentre (Pennsylvania State University, U.S.) http://www.episcenter.psu.edu/	Example of a web-based evidence-gathering and dissemination tool as a centrepiece of KTA activities
ResearchImpact-RéseauImpactRecherche (RIR) (Canada) http://www.researchimpact.ca/localRI/YorkU/	Example of a KTA unit at a Canadian University that is also part of a multi-university collaboration aimed at supporting research use for policy and practice
Social Innovation Generation (SiG) Causeway (Ontario) http://www.sigeneration.ca	Example of diverse organizations collaborating around a common theme
United Way Toronto (UWT) (Ontario, Canada) http://www.unitedwaytoronto.com/	Example of an intermediary organization that has invested in a community of practice approach to mobilize knowledge in youth education
National Treatment Strategy- System Action Network (Canada) http://www.nts-snt.ca/	A national network and strategy for using a systems approach to address substance abuse treatment service gaps and client needs across government jurisdictions and various types of organizations

1) Establish and nurture relationships

Building relationships was a central theme across cases, expressed in different organizational forms (e.g. networks, coalitions, advisory groups). The quality and depth of these connections beyond information sharing was apparent. Having advisors, partners and staff with experience in government, the private sector and the voluntary sector helps with gaining access to different individuals and groups, developing skills in navigating these relationships, and understanding the nuances of language and interpretation. For example, one of the core principles of the Vibrant Communities Initiative of the Tamarack Institute was establishing multisectoral collaborations in communities and providing supports to mobilize and sustain these collaborations. The range of perspectives from voluntary organizations, business leaders, government officials and people who had lived in poverty generated alternative options and built commitment to the strategies that were developed.

2) Co-produce and curate knowledge

Common across all cases was the understanding that KTA for complex problems requires shared interpretation, analysis and sense-making. Expert paradigms of knowledge creation and distribution are not helpful in the realm of the complex. If people who have ideas on how to improve practice are consistently disregarded or they have ideas they had not tried because of lack of time or space to implement them, the potential for change is limited. The metaphor of curating is useful in a few cases when thinking about systems approaches to KTA. Curating is about linking together elements that are similar and different. It is more than asking people what they want to know about; it anticipates what might be interesting and useful to policy and practice but may not be on the radar of relevant groups. For example, CEIPS embraced this approach by integrating research staff into committees of their local health authority to build relationships with practice and policy staff and bring their perspectives more directly into the research work.

3) Create feedback loops

The cases showed that KTA efforts for complex problems require context-specific results tha' convey what works (or does not), for whom, how and in what context. Multiple cases incorporate a feedback loop to help use the knowledge to inform action; this requires reflective evaluation as KTA activities are undertaken and efforts are focussed to revise actions. Such feedback loops contribute to generating pertinent research evidence that is ready for use by policy and practice organizations. For example, INSPIRE created a virtual environment where diverse stakeholders can access and integrate data and information from their different sources to support continuous quality improvement in the delivery of empirically supported interventions. INSPIRE also facilitated gathering of standardized data from many institutions, thus creating a rich data source for studying implementation and outcomes across organizations.

4) Systems interventions are not projects

Some cases faced pressure to produce tangible, short-term outputs. Focussing on systems-level processes and encouraging other organizations to fill identified gaps means that the collaborative efforts are directed at finding new actors, igniting interest in a high-level agenda, and encouraging other organizations with longer-term mandates and with relevant expertise to take leadership on specific actions. For example, SiG Causeway was careful not to create a cumbersome governance structure with ambitions to develop and implement a series of projects. Instead they created a core network of highly engaged leaders drawn from divergent fields, all guided by an overarching strategic framework aimed at igniting cross-sector leadership and shared learning experiences to advance social finance in Canada. These leaders convened showcase and learning events across Canada, hosted webinars to link organizations across sectors to discuss social finance and helped create and populate a common web hub / portal with guides, resources and white papers for translating the concepts into action.

5) Different kinds of supports are needed at different times in different contexts

Even though objectives stayed the same within cases over time, their KTA activities and strategies changed frequently, adapting to the needs of their partners and clients. Cases drew from a diverse range of KTA options and selected those that were the best fit for the time, place, people and purpose. For example, ResearchImpact customized each KTA initiative from a suite of activities that they developed over time. Similarly, the United Way Community of Practice had a range of events for which people can self-select depending on their interests.

Discussion

The 5 guidelines on practical strategies to implement systems approaches to KTA reinforce a subset of system principles. The importance of relationships was particularly reinforced, especially enduring relationships between individuals and groups with diverse perspectives, including from research, policy and practice. Also reinforced was the importance of adapting principles to diverse and dynamic contexts, and feedback for continuous learning. Consistent with the goal of the scan, we identified practical examples of applying these principles. Nonetheless, the results represent a modest start to providing useful insights and guidance to better translate system concepts for KTA into practice. Reflecting on the results, the advisory group identified 3 promising directions for KTA to solve complex problems.

1) Embrace emergent and holistic approaches

Systems approaches challenge assumptions about expectations, guarantees, final answers, and "control," especially by scientists and specialists with particular expertise. In complex and dynamic systems, no patterns stay in place for long and results of interventions may not have the certainty science usually views as desirable. Therefore we need to avoid formulaic approaches, especially across varied contexts; for example, it is not appropriate to replicate a successful intervention with fidelity across diverse communities and

populations. However, recognizing the importance of context does not prevent identifying core components for success and gleaning meaning across diverse contexts or documenting emergent conditions as was done with Tamarack's Vibrant Communities and SiG Causeway work. The development and use of context-sensitive research and evaluation methods are required to learn about what works and how and why. These insights will inform appropriate adaptations of interventions.

Emergent and holistic approaches also require continuous learning. Efforts are needed to continue to evaluate and learn from adaptations and study the processes of refining and scaling up interventions.[37] This creates opportunities to further develop novel and participatory models for conducting evaluations that focus on learning within dynamic environments — in contrast to results-based evaluations that may focus on accountability with little to no consideration of context.

2) Focus on enduring relationships that are solution-oriented

To have an effect, enduring relationships are needed between the policy, practice and research sectors that can nimbly identify, test and adapt solutions to complex problems. During times of limited resources, relationship-building activities can easily be considered luxuries that do not warrant time or funding. However, inclusion of developmental periods for project funding may be an essential ingredient to building effective and relevant interventions and appropriate research methods to harness and use evidence to effect change.

The scan findings from United Way Toronto and the National Treatment Strategy indicate that investment in and the use of community of practice models, though varied in their structure, purpose and aims, may also hold promise in this area. Community of practice models, guided by systems principles, would focus on context-sensitive questions, be oriented toward ongoing learning and diverse exchange, emphasize emergence, value different perspectives and sources of knowledge, and aim to understand the implementation context. Seeking diversity in collaborators and perspectives to engage in solving complex problems implies inclusivity; a conscious bringing together of people who do not necessarily share perspectives, culture or language to work across differences. Power relationships need to be acknowledged and addressed within these collaborations (e.g. how do we give equal voice to participants of different race, gender, class, education). The time and effort required to build enduring and diverse relationships are worthwhile, especially to make sure they are created authentically and sustained.

3) Address gaps in the system in addition to gaps in the evidence

Knowledge development in public health normally focusses on filling gaps in evidence, and especially on providing detailed descriptions of problems. Attention to studying policy and program interventions has been growing recently.[11,38] Consistent with models of places to intervene in complex systems,[3,4] the scan results point to the importance of structural changes (e.g. multi-stakeholder teams, networks) and feedback as valuable *system interventions*. A considerable challenge is limited funding to address these structural elements and other system gaps such as feedback through common measurement approaches across organizations and jurisdictions.[30]

Strengths and limitations

The main strengths of this scan are the importance and relevance of its goals for advancing effective KTA on complex issues such as chronic disease prevention, and the methods we used.

The public health field has placed much more emphasis on defining problems than on developing solutions. Intervening through policies, programs and system changes to address the urgent, serious and complex problems in public health, especially chronic diseases, means working in new ways, including new ways to create and apply knowledge that respects the complexity of the problems. This scan contributes to figuring out how promising approaches to KTA can be implemented in practice.

The strength of our results is enhanced by the methods we used to identify and select a broad range of cases for the scan. The sampling methods resulted in a sizable and manageable number of relevant cases with substantial diversity. Results were also strengthened by the systematic approach to the selection, collection and analysis of information within and across cases and the use of information from both documents and interviews.

The scan was limited by its modest scope because of limited resources. The scan was designed as a preliminary and exploratory analysis. Results suggest there is much to learn about KTA for solving complex problems from existing efforts. More in-depth qualitative and quantitative study and observation of KTA initiatives using system approaches would yield more extensive insights. Learning over a longer period of time from the cases included in the scan and others would also be useful, especially to better understand ways to facilitate dynamic KTA processes and their effectiveness under different conditions.

Conclusion

Ways to address the burden of chronic disease must respect the complexity of these problems and related environments, including the nature of the knowledge needed to address such problems and how and why knowledge is created and used. Learning from existing examples of systems approaches to KTA can identify practical implementation strategies. These strategies may be enhanced by emphasizing a holistic science with a focus on adaptation of interventions, strengthening enduring relationships that bring together diverse perspectives and assets, and addressing gaps in the *system* in addition to gaps in the *evidence*. In turn, at least small gains in changing environments, organizations and behaviours to solve complex public health problems can be achieved.

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Physical inactivity and television-viewing time among Aboriginal adults with asthma: a cross-sectional analysis of the Aboriginal Peoples Survey

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Abstract

Introduction: The purpose of this analysis was to 1) determine the association between asthma and physical activity levels or sedentary time among Aboriginal adults, and 2) understand the influence of physical inactivity and sedentary time on health care use among Aboriginal adults with asthma.

Methods: We analyzed 20 953 adults from the 2006 Aboriginal Peoples Survey. Those with self-reported physician-diagnosed asthma and a current prescription for asthma medication were considered to have current asthma. Insufficient physical activity was defined as < 3 hours/week of moderate to vigorous physical activity; high television screen time was defined as > 10 hours/week. Health care use was assessed using the number of health professional visits and overnight hospital stays.

Results: Aboriginal adults with asthma were more likely to report high television-viewing time (OR = 1.16; CI: 1.11–1.22) and insufficient physical activity (OR = 1.15; CI: 1.10–1.20) than those without asthma. Those with asthma who reported high television-viewing time reported more health professional consults in the past 12 months (OR = 2.59; CI: 2.34–2.87), more overnight stays in hospital in the past year (OR = 1.95; CI: 1.82–2.08) and more overnight stays in the hospital in the past 5 years (OR = 1.13; CI: 1.07–1.18); results were less consistent for physical activity and health care use.

Conclusion: These findings suggest that Aboriginal adults with asthma are less active than their peers without asthma and that such a lifestyle may be associated with higher health care use. These findings have implications for physical activity promotion and sedentary behaviour strategies targeting Aboriginal adults with asthma.

Keywords: physical activity, sedentary lifestyle, chronic disease, asthma control

Key findings

- Aboriginal adults with asthma are more sedentary and less physically active than their peers without asthma.
- Further, Aboriginal adults with asthma who report high levels of television-viewing time are more likely to use health care services than their less sedentary peers.

Introduction

Aboriginal adults in Canada have a disproportionately high burden of chronic disease, increased mortality and decreased life expectancy.[1] Research has shown that off-reserve First Nations, Métis and Inuit adults also have a higher prevalence of asthma (13%–14%) compared to non-Aboriginal adults (8.6%).[2] Low socioeconomic status, limited access to health care services and poor treatment adherence are partly responsible for this discrepancy.[3]

Between 1998 and 2001, asthma-related symptoms were responsible for more than 80 000 hospital admissions.[4] In 2011, the overall economic burden of asthma in Canada, including direct costs and indirect costs, was more than $2 billion.[5] Similar data on asthma-related hospitalizations among Aboriginal people is not available. However, a longitudinal study in Saskatchewan found that Registered Indians aged 35 to 64 years showed a significantly higher risk of hospitalization for asthma.[6] Another retrospective cohort study in Alberta found that Treaty Indians were 2 times more likely to visit a hospital emergency department for asthma or COPD-related symptoms than non-Aboriginal people; however, they were less likely to see a specialist or undergo spirometry testing.[3]

Research has shown that physical activity reduces the incidence and may help prevent the progression of conditions such as diabetes, high blood pressure, cardiovascular disease, asthma, arthritis and poor health.[7,8] The most recent data on physical activity rates among Aboriginal people in Canada indicate that only 21% of on-reserve First Nations are physically active[9] compared to 53.8% of non-Aboriginal people.[10] Lower physical activity rates may partially explain the higher incidence and worse management of chronic disease in this population.[9] Regular physical activity is associated with improved asthma control[11] as well as lower health care use.[12] Activity limitation is an important criteria in the assessment of asthma control.[13]

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Unfortunately, there is a dearth of data on the effect of sedentary behaviour on asthma control. Recent research indicates that sedentary behaviour, which refers to time spent sitting while commuting, working or during leisure time,[14] is an independent risk factor for chronic morbidity and all-cause mortality.[15] A large proportion of leisure sedentary time is made up of screen time, specifically, television time.[16] In fact, television time contributes to the highest amount of daily screen time among Canadian adults, with 29% of this population reporting 15 or more hours a week (> 2 hours per day) in 2007.[17] A recent study also found that 64% of Metis reported watching TV for more than 6 hours per week.[18] However, the impact of such sedentary activities on asthma outcomes is unclear.

Aboriginal people in Canada have a higher prevalence of asthma[2], appear to have worse asthma control[19] and have higher levels of physical inactivity.[9] Given the established link between physical activity and asthma-related health outcomes, a better understanding of the association between asthma, engaging in regular physical activity and having high levels of sedentary time is important to reduce health disparities among Aboriginal people. Therefore, the purpose of our study was 1) to determine the association between asthma and physical activity levels or sedentary time among Aboriginal adults overall, and among those of different Aboriginal identities, and 2) to understand the influence of physical inactivity and sedentary time on health care use among Aboriginal adults with asthma.

Methods

Data and participants

We used the 2006 Aboriginal Peoples Survey (APS) for the current analysis. The APS is a national survey of Aboriginal people in Canada administered by Statistics Canada. The objective of the APS is to examine issues such as education, language, employment, income, health, mobility and housing among Aboriginal people. The target population includes First Nations, Métis and Inuit people, 6 years and older, living off-reserve in rural, urban or northern areas. All APS data were self-reported through personal interviews conducted by phone or in person.

The 2006 APS sampled 61 041 individuals, of which 80.1% responded. We used the public use microdata file for this study (n = 24 368). Since this study focussed on adults, we excluded from our analysis 3415 individuals younger than 20 years (n = 20 953).

Detailed information about the APS sampling design, data collection and weighting can be found in the 2006 APS concepts and methods guide.[20]

Main variables

Asthma

APS participants were asked whether they had physician-diagnosed asthma. If they answered yes, they were asked whether they were currently receiving treatment or taking medication for their asthma. To ensure that participants had "current" asthma and to prevent misclassification associated with overdiagnosis,[21] we classified those who responded in the affirmative to both questions as having asthma; all other respondents were considered not to have asthma. Defining asthma in this way led to the exclusion of 665 respondents.

Insufficient physical activity (IPA)

This variable was derived from the survey question: "In a typical week, how much time do you spend doing physical activities outside of work that result in an increase in your heart rate and breathing?" Response options were none; from 1 to 2 hours; from 3 to 4 hours; from 5 to 6 hours; from 7 to 10 hours; 11 hours or more. Current physical activity guidelines for adults (18–64 years) recommend at least 150 minutes of moderate- to vigorous-intensity aerobic activity per week;[22] thus, we recoded responses into 2 categories: sufficiently physically active (≥ 3 hours per week) and insufficiently physically active (< 3 hours per week). We chose this conservative threshold to minimize misclassification of physically inactive participants who over-report physical activity levels. There are no reliability or validity data available on this single item question from the APS; however, previous research has shown acceptable levels of validity (compared to data measured by an accelerometer) and reliability of recall of moderate- to vigorous-intensity physical activities.[23,24]

Television-viewing time (TVT)

This variable was derived from the survey question: "In a typical week in the past 3 months, how much time did you usually spend watching television?" Response options were none; less than 1 hour; from 1 to 2 hours; from 3 to 5 hours; from 6 to 10 hours; from 11 to 14 hours; from 15 to 20 hours; 20 hours or more. Responses were recoded into 2 categories: high television-viewing time (TVT) (> 10 hours per week) and lower TVT (≤ 10 hours per week). Current epidemiological research suggests that sedentary activity be limited to less than 2 hours per day or 14 hours per week, with standing breaks after 30 minutes of continuous sitting.[25] TVT accounts for a large amount, but not all, of daily sitting time.[17] Thus, our categorization is likely a conservative cut-point since adults also engage in other sedentary activities such as computer screen time and reading.

Health care use

The following 3 variables were used to assess health care use: spending 1 or more nights in the hospital in the past year (yes or no) or in the past 5 years (yes or no), and consulting a health care professional (including, but not limited to, family physicians, general practitioners, other medical doctors or specialists, nurses and First Nation, Métis or Inuit traditional healers) in the past 12 months (yes or no).

Covariates

One of the covariates in this study was Aboriginal identity, which included the response categories of "single identity: North American Indian only"; "single identity: Métis only"; "single identity: Inuk only"; "multiple identities"; "other Aboriginal identity"; "no Aboriginal identity"; and "non-Inuit in Arctic."

Individuals were selected for the APS based on 4 pre-screening questions in the Statistics Canada 2006 Census. These questions were designed to gather information about ethnic origin, Aboriginal self-reported identity (North American Indian,

Métis, or Inuit), Indian band / First Nation membership and Treaty or Registered Indian status. Those who reported ancestral Aboriginal origin without an identity were considered part of the Aboriginal ancestry-only population and were included in the "no Aboriginal Identity" category.

Individuals with asthma in the "single identity: North American Indian only" (n = 715), "single identity: Métis only" (n = 598) and overall sample (all identities together; n = 1830) categories were further analyzed. The analysis of the overall sample provides useful information about all First Nations (off-reserve), Métis, Inuit and other Aboriginal identities within Canada. We did not analyze other groups individually because of their limited sample size; these included single identity: Inuk only (n = 118); multiple identities (n = 50); other Aboriginal identity (n = 28); no Aboriginal identity (n = 314) and non-Inuit in Arctic (n = 7).

Other variables of interest included socio-demographic and health status. Survey respondents were provided with response options for these variables. Further details on the interpretation of these categories are available in the user guide.[22]

Previous research has indicated that age, sex and geographical location are covariates associated with asthma among all 4 adult Aboriginal groups,[2] and that location has been linked to the availability of health care services and physical activity resources.[26] As a result, demographic covariates included sex (male or female), age categories (20–24; 25–34; 35–44; 45–54; or ≥ 55 years) and geographical location (central metropolitan area; urban; rural or arctic).

Socioeconomic covariates included respondent education (elementary or less; some high school; completed high school; some post-secondary non-university; completed post-secondary non-university; some university; or completed university) and total household total income (< $20,000; $20,000–39,999; $40,000–59,999; $60,000–79,999; $80,000–99,999; ≥ $100,000). These covariates were included because socioeconomic factors have been linked to levels of health and fitness among Aboriginal adults.[27]

Smoking status (daily smoker; occasional smoker but former daily smoker; always an occasional smoker; non-smoker now, former daily smoker; non-smoker now, former occasional smoker; or never smoked) and self-reported body mass index (underweight [BMI < 18.5]; normal weight [18.5–24.9]; overweight [25.0–29.9]; obese Class I [30.0–34.9]; obese Class II [35.0–39.9]; or obese Class III [≥ 40.0]) were included because they are established health-risk factors.[28]

Covariate categories containing less than 5% of the sample were collapsed with an adjacent category. However, the underweight BMI category was not collapsed, as this is a distinct and important category of BMI.

Statistical analysis

Frequencies were used to describe the covariates and outcomes; these were converted into a percentage of the sample. Pearson chi-squares were used to determine whether there were differences between those with and without asthma. In cases where there were more than 2 categories, we used standardized adjusted residuals to determine where the difference was. A cut-point of −2.0 to 2.0 was used to detect significance. Simple and covariate adjusted logistic regression analyses were used to assess the associations between asthma and IPA or TVT in each of the Aboriginal groups and in the overall sample comparing those with and without asthma. Logistic regressions were adjusted for age, sex, Aboriginal identity, geographical location, income, education, type of smoker and BMI covariates. In the sample of adults with asthma, simple and adjusted logistic regression models were used to assess the association between outcomes of health care use and IPA or TVT.

All statistical analyses were conducted using SPSS version 21 and significance was set at $\alpha < 0.05$. In order to ensure appropriate estimations, normalized population weights provided by Statistics Canada were applied to the entire dataset.

Results

The prevalence of asthma in this sample was 8.7%. Within the asthma group, 39.1% were North American Indian, 32.7% were Métis, 11.1% were Inuit or non-Inuit in Arctic or other identity/multiple identities, and 17.2% were no Aboriginal identity. Table 1 shows characteristics of the sample. Significant differences were observed between those with treated asthma and those without asthma on most covariates examined. The proportion of those who were insufficiently physically active was higher among those with asthma (56.9%) compared to those without asthma (50.9%). The proportion of those who reported high TVT was higher among those with asthma (50.4%) compared to those with no asthma (42.9%).

Adults with asthma were significantly more likely to report high TVT and IPA compared to those without asthma in unadjusted models (Table 2). This was true for the North American Indian, Métis and the overall samples. These associations remained significant after adjusting for age, sex, Aboriginal identity, geographical location, income, education, type of smoker and BMI.

The odds of health care use were higher among adults with asthma who had high TVT in unadjusted and adjusted models (Table 3). For IPA, all unadjusted associations with health care use were significant. For health care professional consultations in the unadjusted regression, the association was negative such that IPA was associated with fewer consultations (OR = 0.77; CI: 0.71–0.84), while the association between IPA and hospital night stays in the past year (OR = 1.20; CI: 1.13–1.27) and past 5 years (OR = 1.49; CI: 1.43–1.56) were both positive. In models adjusted for all covariates, hospital night stays in the past year and 5 years were both significantly associated with IPA.

Discussion

Using a sample of adults from the 2006 APS, we analyzed the relationships between physical inactivity and TVT with asthma and health care use. The primary finding is that adults with asthma were significantly more likely to be in the high television-viewing-time group (> 10 hours per week) and to be insufficiently physically active (< 3 hours per week) compared to those

TABLE 1
Characteristics of the sample by self-reported asthma, Aboriginal Peoples Survey, 2006

Characteristics		Asthma – treated (n = 1830), %	No asthma (n = 18 313), %	Asthma – not treated (n = 665), %
Age, years	20–24	11.6	11.6	18.9*
	25–34	19.0	21.8*	26.1*
	35–44	21.8	24.5	20.3
	45–54	20.2	22.0*	17.4
	≥ 55	27.4	20.0*	17.3*
Sex	Male	30.8	46.0*	33.3*
	Female	69.2	54.0*	66.7*
Aboriginal identity	North American Indian	39.1	36.7	36.9
	Métis	32.7	30.5	33.3
	Inuk or non-Inuit in Arctic or other identity/multiple identities	11.1	15.2	8.6
	No Aboriginal identity	17.2	17.6*	21.2
Geographical location	Central metropolitan area	46.4	40.0*	52.3*
	Urban	21.2	22.3	21.2
	Rural	26.6	27.8	23.4
	Arctic	5.3	9.9*	3.2*
Income, $	< 20 000	17.4	12.9	16.4
	20 000–39 999	24.3	20.4	22.9
	40 000–59 999	18.9	19.2	18.0
	60 000–79 999	13.3	15.6	13.7
	80 000–99 999	10.4	12.1	10.5
	≥ 100 000	15.7	19.8	18.5
Education	Less than high school	28.6	26.7*	24.1*
	Completed high school	14.2	15.3	16.8
	Some post-secondary non-university	11.5	10.5	10.1
	Completed post-secondary non-university	29.9	29.9	28.7
	Some or completed university	15.8	17.6*	20.3*
Type of smoker	Daily	33.1	33.8	35.6
	Occasional smoker (former daily or always)	9.0	8.3	6.7
	Non-smoker (former daily or occasional)	33.6	31.2*	24.5*
	Never smoked	24.4	26.8*	33.2*
Body mass index, kg/m^2	< 18.5 (Underweight)	2.0	1.7	2.3
	18.5–24.9 (Normal weight)	30.4	35.5	30.7
	25.0–29.9 (Overweight)	31.2	37.2	31.6
	30.0–34.9 (Obese Class I)	22.3	18.0	22.2
	≥ 35.0 (Obese Class II or III)	14.2	7.6*	13.2*
Overnight hospital stay in the past 1 year		20.3	11.1*	13.3*
Overnight hospital stay in the past 5 years		48.4	32.9*	38.6*
Health professional consultation in the past 1 year		95.0	89.6*	91.7*
Physical activity level, hours	None	17.8	13.9	13.4
	1–2	39.1	37.7	35.7
	3–4	20.1	21.5	23.0
	5–6	9.3	11.9	9.6
	7–10	8.6	9.1	10.0
	≥ 11	5.1	6.0	8.2

Continued on the following page

TABLE 1 (continued)
Characteristics of the sample by self-reported asthma, Aboriginal Peoples Survey, 2006

Characteristics		Asthma – treated (n = 1830), %	No asthma (n = 18 313), %	Asthma – not treated (n = 665), %
Physical activity	Insufficient (< 3 hours/week)	56.9	50.9*	54.8*
Television time	Sedentary (> 10 hours/week)	50.4	42.9*	42.6*

* $p < .05$.

without asthma; this was true for the North American Indian and Metis groups as well as the overall sample. The secondary finding is that adults with asthma who reported high TVT used health care services more than those who reported lower TVT, and that adults with asthma who were insufficiently physically active reported more hospital stays than those who were sufficiently active. While previous research has concluded that individuals with asthma are more likely to report low physical activity levels[29] and higher health care utilization,[12] this is the first study to investigate these relationships within the Aboriginal population in Canada and within different Aboriginal identities, each of which may be at varying risk due to a multitude of health disparities.[30]

Our finding that Aboriginal adults with asthma are more likely to report lower levels of physical activity is consistent with findings from research on non-Aboriginal adults with asthma.[28] Many individuals with asthma avoid physical activity for fear of exacerbating symptoms or triggering exercise-induced bronchoconstriction.[31] However, numerous studies have shown that physical activity can improve asthma control and asthma-related quality of life.[11,31] Dogra et al.[12] investigated the relationship between physical activity and health in 4272 men and 6971 women with asthma from the Canadian Community Health Survey cycle 2.1. Data showed that physical activity was consistently associated with better health in individuals with asthma.[12] Further, engaging in regular, structured physical activity has been shown to improve asthma control in adults with asthma.[11] Thus, physical activity promotion strategies among Aboriginal people may benefit from an asthma education component, and asthma education should include information on physical activity.

The results of our study also indicate that North American Indians living off-reserve, Métis and the overall Aboriginal population group with asthma were more likely to report high TVT compared with those without asthma. Only a limited number of studies exist on the association between asthma and TVT, and these are primarily on children. In one such study, children presenting with no wheeze at 3.5 years

TABLE 2
Television-viewing time and physical inactivity in North American Indian populations, Métis populations and the overall Aboriginal sample, ≥ 20 years, Aboriginal Peoples Survey, 2006

Aboriginal group	Asthma status	High television-viewing time OR (95% CI)		Insufficient physical activity OR (95% CI)	
		Unadjusted	Adjusted	Unadjusted	Adjusted
North American Indian only	Asthma	1.40*** (1.21–1.62) n = 75	1.57*** (1.27–1.94) n = 70	2.30*** (1.99–2.66) n = 76	2.04*** (1.53–2.72) n = 70
	No asthma	Referent n = 24	Referent n = 24	Referent n = 24	Referent n = 24
Métis only	Asthma	1.39*** (1.33–1.46) n = 572	1.32*** (1.25–1.39) n = 529	1.50*** (1.43–1.57) n = 571	1.17*** (1.11–1.23) n = 528
	No asthma	Referent n = 209	Referent n = 194	Referent n = 210	Referent n = 195
Overall sample	Asthma	1.29*** (1.24–1.34) n = 800	1.16*** (1.11–1.22) n = 743	1.52*** (1.46–1.58) n = 800	1.15*** (1.10–1.20) n = 742
	No Asthma	Referent n = 289	Referent n = 273	Referent n = 291	Referent n = 275

Abbreviations: BMI, body mass index; CI, confidence interval; OR, odds ratio.

Notes: Response rates for physical activity and television-viewing time variables were 8.2% in North American Indians compared to 95% in Métis.

Adjusted for age, sex, geographical location, income, education, type of smoker, and BMI.

*** $p < .001$.

TABLE 3
Association between health care utilization and physical inactivity or television-viewing time among Aboriginal adults (≥ 20 years) with asthma, Aboriginal Peoples Survey, 2006

Activity type		Health care professional[a] consultation, OR (95% CI)		Overnight hospital stay in the past year, OR (95% CI)		Overnight hospital stay in the past 5 years, OR (95% CI)	
		Unadjusted	Adjusted[b]	Unadjusted	Adjusted[b]	Unadjusted	Adjusted[b]
Television screen time >10 hours/ week	Sedentary	2.41*** (2.21–2.63) n = 403	2.59*** (2.34–2.87) n = 372	2.19*** (2.07–2.32) n = 401	1.95*** (1.82–2.08) n = 370	1.47*** (1.41–1.53) n = 396	1.13*** (1.07–1.18) n = 370
	Active	Referent n = 397	Referent n = 371	Referent n = 394	Referent n = 369	Referent n = 401	Referent n = 370
Insufficient physical activity < 3 hours/week	Insufficiently active	0.77*** (0.71–0.84) n = 455	0.98 (0.89–1.08) n = 422	1.20*** (1.13–1.27) n = 453	1.16*** (1.08–1.23) n = 421	1.49*** (1.43–1.56) n = 452	1.22** (1.16–1.28) n = 419
	Active	Referent n = 345	Referent n = 320	Referent n = 342	Referent n = 317	Referent n = 345	Referent n = 320

Abbreviations: CI, confidence interval; OR, odds ratio.

[a] Including, but not limited to, family physicians, general practitioner, other medical doctor or specialist, nurse or First Nation, Métis or Inuit traditional healer.

[b] Adjusted for age, sex, Aboriginal identity, geographical location, income, education, type of smoker and body mass index.

** $p < .01$.

*** $p < .001$.

were followed over a 7.5-year prospective longitudinal study, during which television screen time rates were recorded.[32] The results showed that children who watched an average of 2 or more hours of television per day over the 7.5-year period were more than twice as likely to develop asthma by 11.5 years of age.[32] Further, a number of adverse health outcomes, including obesity, behavioural problems and decreased academic performance, are associated with excessive screen time [33] and are all more prevalent among children with asthma.[34] Recent evidence has also indicated that sedentary behaviour, including TVT, is an important risk factor for cardiovascular disease and all-cause mortality independent of physical inactivity.[35] Since Aboriginal people are already at a higher risk of many of these adverse health outcomes,[1] the high TVT reported among Aboriginal adults with asthma in this study highlights a potential target for future health promotion strategies.

Research has shown that Aboriginal people in Canada visit the hospital more than twice as frequently as do their non-Aboriginal peers.[3] Our study found that adults with asthma who reported high TVT had higher health care utilization. This is not surprising given the multitude of adverse health outcomes associated with high TVT.[31-33] Similarly, adults with asthma who were insufficiently active had significantly higher odds of being hospitalized overnight in the past year. This is consistent with previous results from the Canadian Community Health Survey that indicated that physically active adults with asthma use health care services less than inactive adults with asthma do; that is, they have better asthma control.[12] Of note, the association between physical inactivity and health care use was less consistent; no statistical significance was noted for health care professional consultations. The inconsistent findings for physical inactivity and health care utilization, especially consultations with a professional, may be confounded by exercise-induced asthma, that is, active adults with asthma may be seeking health care services to ensure they have medications to prevent inactivity related to asthma symptoms. Future research should consider more objective measures of asthma control and should consider exercise-induced asthma.

Evidence is growing that the impact of screen time on health outcomes is independent of physical activity;[35] from this preliminary descriptive study, it is difficult to determine whether sedentary time may be more important than physical inactivity for asthma outcomes in this population. Certainly, more research is required. Regardless, data from the present study clearly show that Aboriginal adults with asthma need to increase their physical activity and reduce their TVT; doing so could lead to an increase in asthma control, a decrease in health care costs and likely better quality of life.

Strengths and limitations

The strengths of this analysis include the large sample size, which allowed for analysis in 2 distinct Aboriginal identities, and the number of available variables in the APS that were adjusted for in regression models. Results of this study should be interpreted in light of the following limitations.

First, the data used in this study were cross-sectional; thus, reverse causality cannot be ruled out. Second, covariates not measured in the study, such as exercise-induced asthma, could be responsible for a confounding variable effect. Third, all data were self-reported, which may have led to misclassification, especially in regards to physical activity, sedentary behaviour and BMI. For physical activity and sedentary behaviour,

recall has been shown to have acceptable validity and reliability when using 7-day recall questionnaires[23,24] whereas self-reported BMI can accurately predict measured BMI.[36] However, objectively measured data are better able to predict health outcomes[37] when compared to self-reported data. As such, conservative cut-points were deliberately chosen to minimize bias in the present study. Future research should use objectively measured or valid/reliable tools to measure these variables.

Fourth, the sample did not include on-reserve First Nations and the sample size was not large enough to run individual analyses for all Aboriginal identities, both of which may limit the generalizability of the findings. It should also be noted that the APS does not contain information necessary for detailed analyses of health care accessibility within these identities. Future research should assess asthma among First Nations, Métis and Inuit separately to better understand the associations within these specific populations. Fifth, the APS did not contain information pertaining to asthma control, so health care use outcomes were used as a proxy. Future research should directly assess the association between IPA, TVT and asthma control in Aboriginal adults with asthma, both on- and off-reserve. Finally, the present analysis was the first to explore such associations in Aboriginal adults. Future research should test for potential effect modifiers to determine if the associations differ by variables such as smoking status, medication use and others.

Conclusion

Data from the APS indicate that Aboriginal adults with asthma are more sedentary and less physically active than their non-asthmatic peers. Further, Aboriginal adults with asthma who report higher levels of TVT are more likely to use health care services than their less sedentary peers. These novel findings have important implications for asthma-exercise education in the Aboriginal population in Canada.

Conflict of interest

The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the paper.

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